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TEACHING TO ENHANCE STUDENT LEARNING FROM A PERSPECTIVE OF BRAIN FUNCTIONS

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ABSTRACT

This paper studies two major brain models, namely the right and left brain model and the dual systems model, and their applications in enhancing student learning in the higher education context. The right and left brain model suggests that students may be right- or left- brain dominant and, thus, have different learning preferences and capabilities. The dual systems model suggests that there are two thinking approaches, namely System 1 thinking (intuitive thinking) and System 2 thinking (deep thinking). Students may use System 1 thinking to solve problems quickly but sometimes inaccurately, while they may also use System 2 thinking with more effort to obtain the right answer. A number of university students were asked to complete the Cognitive Reflection Test (CRT) and an online brain dominance test in the experiment. The CRT test checked for System 1 or System 2 thinking in problem solving. The online brain dominance test was used to determine which brain hemisphere was used predominantly by the subject. Results showed that learners who are right-brain dominant had a higher tendency to use System 1 thinking and, thus, increases the chances of providing wrong answers to the questions. The paper also discussed how to design teaching and learning activities to suit the brain dominance of learners, and illustrate with examples how to develop System 2 thinking skills, especially in those who are right-brained. Understanding how students learn and think is important for educators to enhance students' learning experience, help students overcome their weaknesses and, thus, increase their learning interest and efficiency.

KEYWORDS : Right and Left Brain Model, Dual Systems Model, System 1 Thinking, System 2 Thinking, Cognitive Reflection Test, Student Learning

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INTRODUCTION

Current knowledge on the functions of a brain can help us to understand our strengths and weaknesses and, thus, enhance and support teaching and learning activities in the education context. Recent research on cognitive neuroscience, psychology and biology provides information about how our brains perform physiologically and this leads to discoveries that people can learn better, based on the characteristics of their brains. There are two brain models that can help explain the learning behaviors of students: (1) the right and left brain model and (2) the dual systems model.

Brain asymmetry is emphasized in the right and left brain model and usually associated with complementary functions. While intuition and creativity are manipulated by the right brain; logical thinking and language processing are controlled by the left brain (Macneilage, Rogers & Vallortigara, 2009; Rangarajan & Parvizi, 2016). In the dual systems model (Kahneman, 2013), System 1 is an unconscious, instinctive and fast way of thinking. There is no function of voluntary control and it also requires little or no effort. However, it is

prone to biases and mistakes. System 2 is a coordinated, effortful and time-consuming way of thinking. It requires effort and concentration. It is a logical and conscious manner of decision making that filters the instincts of System 1.

The right brain performs intuitively and creatively. This may be connected to the fast, automatic and unconscious way of thinking in System 1. Similarly, the left brain performs logically and analytically. This may be connected to the slow, effortful and controlled way of thinking in System 2. This paper aims to find out if there is any relationship between these two brain models by collecting the statistical data from students who responded to questions reflecting their brain characteristics. The results of this study will provide practitioners with implications in designing the program curriculum and course syllabus, which in turn, helps students to strengthen their learning capabilities and alleviate problems associated with their weaknesses. This paper will first introduce the two brain models, and then will discuss the experiment design and the results. Finally, a number of suggestions for improving teaching and learning performance, based on these two brain models, will be provided.

TWO BRAIN MODELS

How do our brains learn? The answer to this question is the central issue of brain-based learning. Extant studies have reported two major brain models: the right and left brain model and the dual systems model. In this section, these two brain models will be introduced with the emphasis on its relationship with teaching and learning activities.

Right and Left Brain Model

Brain asymmetry is inborn and controlled genetically (Corballis, 2014; Gainotti, 2015) and supports the functional evolution such as the usage of different tools and languages. The human brain consists of two hemispheres connected by the corpus callosum. Right and left hemispheres control the movements of the opposite sides of the human body. For example, the right hemisphere processes visual signals from the left eye, while the left hemisphere processes those signals from the right one. Normally, the entire brain works as a whole to create a complete human being but individuals have tendencies toward a particular hemisphere. A left-brained person is described as more objective and logical while a right-brained person is described as more subjective and intuitive.

In the 1960s, it was found that cutting the corpus callosum reduced seizures in patients with epilepsy and that the two hemispheres performed different tasks. The concept of left and right brain thinking was developed by Sperry (1968), a Nobel laureate, who discovered that the right brain manipulates information in an intuitive and simultaneous manner while the left brain manipulates information analytically and sequentially. Table 1 shows the general features of left-brained and right-brained learners (Scull, 2010).

Left-brain dominant learners are usually good at mathematical and logical problems and prefer listening to lectures and absorbing teaching materials in logical steps. They take notes in a well-organized manner, read instructions thoroughly and seek definitive answers. Right-brain dominant learners are usually good at creating arts, learning languages, and exploring and experimenting. They like learning through doing instead of observing. They are often thought to be disorganized and easily distracted. They are often classified as visual-spatial learners who prefer learning with visual aids and receiving all information given simultaneously. Thus, they feel uncomfortable when facing, for example, complicated mathematical tasks involving multiple steps of direction. Although left and right hemispheres function differently, it is only a different way of thinking and one is not better than the other. Students should understand their own natural preferences and pay attention to their less dominant side for improvement. For example, children working on

mathematical problems using an abacus can activate both hemispheres of their brains through active learning and may retain knowledge better and become more proficient in various subjects.

Table 1: Features of Left-Brained and Right-Brained Learners (Scull, 2010)

Features of Left Brained Learners	Features of Right Brained Learners
Information processed in a sequential order linearly	Information processed in a varied order randomly
Work in a sequential and analytical manner	Work in an intuitive and simultaneous manner; Imaginative and even fantasy orientated
Good at checking their work and meeting deadlines	Find deadlines difficult to meet
Logical responses	Emotive responses
Planned action	Impulsive action
Recall names of people	Recall faces of people
Good listener	Musical and/or artistic
Verbal information processing; Good with words	Visual information processing; Good with shapes and patterns and sensitive to colors
Give and follow directions and instructions	Prefer learning by demonstration, pictures, videos, diagrams, etc
Organize others	Appear disorganized
Formal study design preferred	Frequent mobility while studying preferred
Looking at the pieces then combining them together as a whole	Looking at the whole picture
Uncomfortable with unstructured and open-ended assignments	Prefer selecting own assignments involving creativity

Dual Systems Model

There are two decision-making systems located in two different regions of a brain (Miller & Cohen, 2001), namely pre-frontal lobe and the subcortical structures. The former is responsible for higher-power thinking, analysis and problem solving while the latter is for routine, emotional and reflexive decisions. Pre-frontal lobe requires concentration and processes one decision at a time serially at high cost while subcortical structures make decisions in a parallel manner fast at low cost. In line with this brain structure, the dual systems were proposed by Kahneman (2003, 2013), another Nobel laureate. He described two different ways in which the brain performs analysis. System 1 accepts visible evidence presented as the only source of information and knowledge and omits other important but hidden evidence. System 1 evolved for quick responses. Our ancestors could not afford to take much time to arrive at decisions on a matters related to life and death. System 2 is more complicated and well developed only in human beings. It can recognize and analyze what is not obvious. Table 2 shows the characteristics of these two systems.

The two systems work differently. Adding two and two is done using System 1 thinking, while the product of 53 and 27 is arrived at using System 2 thinking. System 1 works all the time because its tasks are not difficult and System 2 needs effort taking over the whole body and works only infrequently and reluctantly. People may be able to solve problems correctly but they do not like the physical strain that requires careful thought. They may sometimes make decisions based on uncontrolled and impulsive judgements leading to errors in their responses while they may sometimes use controlled and deliberate reasoning to avoid such a kind of mistakes. The first answer that comes to our mind may be incorrect and cognitive reflection (or further thinking) is required to arrive at the correct answer.

Table 2: Characteristics of System 1 and System 2 Thinking

System 1 Thinking (Evans, 2008; Stanovich, 1999; Stanovich& West, 2000)	System 2 Thinking (Epstein, 1994; Epstein, 2008;Epstein *et al.*, 1996)
Relatively fast operation	Relatively slow operation
Automatic	Rule-based and analytical
Uncontrolled and impulsive	Controlled
Acquired biologically with personal experience	Acquired by formal and cultural tuition
Cognitive capacity not demanded	Cognitive capacity demanded

Human beings are born with the ability to perceive information from various sources. We use both System 1 and System 2 thinking in our daily lives and these two systems complement each other. The division of labor between these two systems improves performance and reduces efforts. System 1 generally works well in familiar situations and its short-term operations are often accurate and its initial responses to problems are usually appropriate. System 1 is often running in the background of our minds and it cannot be switched off deliberately. However, System 1 has limitations as it does not assess logical and statistical situations correctly and it may interrupt situations requiring System 2 and results in a making wrong decision. Many problems have characteristics for which routine reflexive responses are inappropriate. More cognitive reflection is needed to obtain a right response. Thus, students should be trained to be more "reflective" and they need to resist the urge to give an intuitive but incorrect answer. Correct answers can be obtained only upon cognitive reflection that needs a higher level of thinking.

Critical and deep thinking is usually a training objective in higher education. Students should develop analytical skills to understand problems and suggest solutions. Thus, System 2 thinking is necessary for this purpose. Since the left brain performs logically and analytically, left brain thinking may be related to System 2 thinking. Similarly, since the right brain performs intuitively, the right brain thinking may be related to System 1 thinking. This paper seeks to determine if these brain models are related. Understanding thinking approaches of students can help instructors in for the design of the curriculum, syllabus, learning activities from a perspective of the brain functions. In the following section, an experiment to test the correlation between these two brain models will be described and the results will be presented.

EXPERIMENT DESIGN AND RESULTS

The experiment consisted of two tests. The first test, the Cognitive Reflection Test (CRT), was to determine if a subject used System 2 thinking to solve a set of problems. The second test, a brain dominance test, was used to determine which brain hemisphere a subject used more dominantly. Frederick's CRT was developed to measure one's ability to arrive at the correct answer after cognitive reflection (Frederick, 2005). The test consisted of three questions below and the intuitive (but wrong) answers and right answers to these are shown in Table 3.

- *A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?*
- *If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?*
- *In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?*

Table 3: Answers to the Cognitive Reflection Test (Frederick, 2005)

	Right Answers	Intuitive (but wrong) Answers	Explanation for Wrong Answers
Q1	5 cents	10 cents	Simple subtraction between two numbers
Q2	5 minutes	100 minutes	Simple projection based on two instances of 100
Q3	47 days	24 days	48 days is mistakenly processed as 48 *hours* and a half of 48 is 24

The brain dominance test adopted in this experiment was developed by Sommer + Sommer (2013). In this online test, the subject answered questions on his/her actions that reflect his/her brain dominance. For example, "*When you put your hand on your head, which hand did you use? When you cross your legs, which leg is on top?"*At the end of the test, the subject is shown two figures (in percentages) indicating the dominance of the right and left side of the brain, like the example in Figure 1.

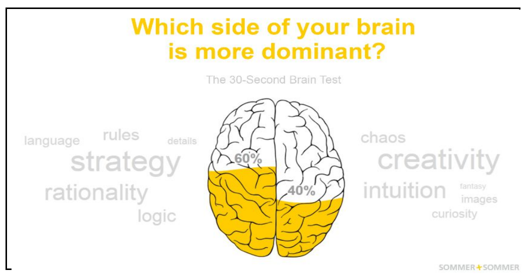


Figure 1: Example of Brain Dominance Test Result (Source: http://braintest.sommer-sommer.com/en/)

A total of 51 students studying various disciplines in a university were invited to participate in this experiment. These were asked to take the Cognitive Reflection Test followed by the online Sommer + Sommer test. For each question in the CRT, more than half the subjects were able to provide the correct answer (see Table 4). About 14% of the subjects provided incorrect answers to all three questions while about 26% were able to answer all three questions correctly (see Table 5). The subjects were divided into two groups based on whether they provided any incorrect answers in the CRT (see Table 6). T-tests showed the difference between the two groups (At least one incorrect answer vs. and All correct answers) in terms of brain dominance was statistically significant ($p<0.05$). Subjects who were able to answer all three questions correctly appear to have a more balanced usage of their left and right brains while those who made at least one mistake were more right-dominated (Right 58.3% vs. Left 41.7%). It appears that right-brained learners had a higher tendency to use System 1 thinking to solve problems. This should be considered when the curriculum, syllabus and teaching and learning materials are designed and applied to help students to develop System 2 thinking skills and techniques.

Table 4: Percentage of Questions Answered Correctly in the Cognitive Reflection Test

	Percentage of subjects answering correctly in the CRT
Q1	62.7%
Q2	56.9%
Q3	52.9%

Table 5: Percentage of Subjects Answering Correctly in the Cognitive Reflection Test

	Percentage of Subjects in the CRT
0 question answered correctly	13.7%
1 question answered correctly	25.5%
2 questions answered correctly	35.3%
3 questions answered correctly	25.5%
Total	**100.0%**

Table 6: Comparison of Subjects with and without Mistakes in Cognitive Reflection Test

	Average Dominance Percentages		T-Test Results	
	Subjects with at Least One Incorrect Answer In the CRT (N=38)	Subjects With All Correct Answers In The CRT (N=13)	T-Value	P-Value
Left brain	41.7%	53.4%	-2.2386	0.0148 < 0.05
Right brain	58.3%	46.6%	2.2061	0.0160 < 0.05
Total	**100.0%**	**100.0%**		

TEACHING AND LEARNING FROM A PERSPECTIVE OF BRAIN FUNCTIONS

The above results showed that students vary in their brain dominance and their tendency in applying System 2 thinking. Instructors will greatly benefit from knowing students' preference in terms of brain functions (Cherry, Godwin & Staples, 1989). Students will show greater interest when teachers prepare lessons suited to their learning style. In this section, we will suggest teaching and learning activities for students to use their hemispheric strength and enrich the capabilities of their dominant hemispheres. Suggestions on how to develop System 2 thinking for right-brained students are also provided at the end of this section.

Teaching Left-Brained Learners

There are various ways to customize lessons for left-brained learners. First, left-brained students usually adapt to their environment. Showing an outline of the lesson helps students to follow in a step-by-step manner and helps them grasp the knowledge more readily. The left hemisphere manages information linearly and processes from the pieces to the whole and organizes them in a logical order. When they find it difficult to learn in a classroom, an instructor may need to arrange learning materials in a logical order.

Second, asking students to take notes helps them to organize knowledge in a detailed manner. They are good at meeting deadlines and listening to and following instructions. They will be uncomfortable in an unstructured learning environment. They listen to lectures and make linear notes and help them to remember.

Third, left-brained learners like making lists of detailed items and doing things with daily planning. They do not act impulsively and prefer breaking tasks down into small structured steps. They enjoy completing jobs in a particular order and are pleased after checking them off on the job list.

Fourth, left-brained students like working independently and instructors should strike a balance between teamwork and individual projects that allow them to work on their own. They can adapt better to online learning. They also like working in a well-organized classroom quietly.

Teaching Right-Brained Learners

There are various ways to encourage right-brained learners to enhance learning. First, right-brained learners are usually guided by their feelings and prefer being given the whole picture of a task ahead. They are usually creative, imaginative and skilled in spatial tasks. They may suggest good ideas but are not interested in the detailed implementation of the plan. To help them utilize their left hemisphere, an instructor may turn a challenging mathematical assignment into a creative experience and encourage students to think differently. The instructor may assist students to take notes or draw mind maps to help them to remember details.

Second, when they are familiar with the knowledge, they may be encouraged to work alone. Right-brained learners like working with others and tapping into their left hemispheres helps them to focus on the task at hand. In online courses, students can be encouraged to collaborate with others on projects.

Third, right-brained learners like learning through using colors. For example, using various colors to highlight main points can help them to remember the differences and relationships among the points. In addition, visual charts, pictures and other visual aids make it easier for them to organize, plan and keep information in their mind, and this can facilitate discussion of an assignment with instructors and other students. Course websites should have attractive graphics. Video demonstrations are preferred.

Fourth, right-brained learners do not like working under pressure with tight time constraints. They should be given sufficient time to get their jobs done. Assistance can be offered to them without judgement to complete the tasks.

While right-brained and left-brained learners may show different characteristics of learning styles, there is a common area for most learners. In general, a student does not have to be strictly right- or left-brained and they may show traits of both. An instructor may incorporate right-brained and left-brained activities equally in the classroom.

Teaching Whole Brained Learners

Students who use both hemispheres are likely to be the most effective. They are creative and imaginative with outstanding spatial skills and have organizational skills to make their ideas work. They process the whole picture of a task and break it down into manageable pieces and accomplish the task within a time frame. They can work well with others because they can adapt to new ideas and a new working environment.

In real life, individuals use both hemispheres simultaneously (Lin & Burdine, 2005; Niles, 2010). For example, a visual presentation is helpful to every learner and a left-brained student should not be excluded from right-brained presentation. Whole brained teaching and learning strategies are constructive to both hemispheres. For instance, soothing colors and music relax all learners while imaging techniques like visualization provide content to reinforce learning effects. Some functions involve both hemispheres of the brain. The long-term memory is stored in the right hemisphere while the short-term one is in the left hemisphere. Thus, memorizing facts and figures help us to keep them in the left hemisphere and the visual contexts are useful for keeping them in the right hemisphere. When children are not good at memorizing, the information may be conveyed in a visual manner. They can still learn through left brain processes but only effectively with a visual presentation.

Enhancing System 2 Thinking

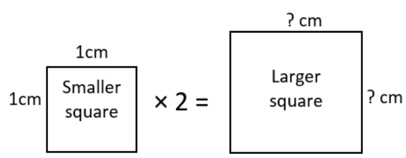
System 2 thinking is a coordinated, effortful and slow way of thinking. Instructors should encourage students take efforts and time to analyze problems in a logical and well-ordered manner. The following is an example of question design that illustrates how to foster System 2 thinking. Take the following question:

The area of a square is twice that of another square. The side length of the smaller square is 1cm. What is the side length of the <u>*larger*</u> *one?*

The intuitive but wrong answer is 2cm that is acutely the projection based on the concepts of "*twice*" and "*1cm*" directly. If choices like those below are provided, students may be encouraged to attempt each choice to find the correct answer. Trials and comparisons are part of System 2 thinking techniques. Students are trained to attempt a few more possibilities before they jump to the conclusion using System 1 thinking.

☐ A. 2 cm ☐ B. ½ cm ☐ C. $\sqrt{2}$cm

Another way to is to provide a diagram like the following:



This visual aid helps students, especially right-brained ones, to view the whole picture of the problem more easily. Students may first ask themselves, "*What is the area of the larger square?*" It should be $2cm^2$. Then, they know that 2cm x 2cm is equal to $4cm^2$ and, thus, 2cm is a wrong answer although that may be the intuitive answer. So they will use the formula $x^2 = 2$ and arrive at the answer $x = \sqrt{2}$. This example illustrates how to solve a problem in a stepwise manner correctly although it is slower and requires more effort.

Cognitive strain may trigger individuals to use System 2 and analyze the problem more completely. Khaneman (2013) ran a test in which the same set of the CRT questions was presented in two different formats. The results showed that 90% of respondents made, at least, one mistake in the CRT when a bigger and more legible font was used but the proportion was reduced to 35% when a smaller and more illegible font was used. This cognitive strain forced subjects to work harder and triggered them to use System 2.

In the education context, an instructor may present a question with more information to be processed and this can force students to digest and analyze it before jumping to the conclusion immediately. An instructor may inspire students to perform better by challenging the *status quo* to create a sense of urgency (Dess, Lumpkin & Eisner, 2007). This will lead to cognitive strain triggering System 2 and make students utilize more resources to analyze situations better to come to a better decision. For example, the question above may be modified to a more generic one without any numbers mentioned.

The area of a square is ***x*** *times that of another square. The side length of the smaller square is* ***y*** *cm. What is the side length of the* <u>*larger*</u> *one?*

When the question is written this way, students will not have any intuitive answer and will be forced to use System 2 thinking to solve the problem by going through the following steps:

What is the area of the smaller square? *Answer= y2*

What is the area of the larger square? *Answer=* $x\,y^2$

What is the length of the larger square? *Answer* = $\sqrt{x\,y^2} = y\sqrt{x}$

The common mistake in System 1 thinking is to jump to the conclusion or answer without investing more effort. This is also a feature of right-brain thinking which relies more on intuition. Instructors may guide students through the whole analytical and logical process leading to the correct answer. Appropriate teaching techniques like visual aids, hints and a picture showing the whole concept can be helpful for all students, no matter they are left- or right- brained.

CONCLUSIONS

Understanding how brains learn is important for educators to enhance students' learning capabilities and help students to overcome their weaknesses and, thus, increase their learning interests and efficiencies. In this paper, the right and left brain model and the dual systems model were discussed. Instructors should understand the strengths and weaknesses of their students who may be right- or left- brained, and that some may have difficulty using System 2 thinking to solve problems analytically and logically. The experiment showed that the right-brained students tended to provide answers based on their intuition rather than use System 2 thinking. This paper discussed several ways to assist students who are right- or left-brained dominant to learn in the classroom. Various teaching and learning tactics may be utilized to help a student to take advantage of his/her dominant hemispheres and to improve the capability of another hemisphere. Suggestions were also provided for teaching whole brained learners. Examples were presented to illustrate how a simple question can be modified to achieve the goal of training students to use System 2 thinking to solve a problem and avoid relying on intuition.

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REFERENCES

1. *Cherry, C., Godwin, D., & Staples, J. (1989). Is the left brain always right? Carthage, IL: Fearon.*
2. *Corballis, M.C. (2014). Left brain, right brain: Facts and fantasies, PLoS Biology, 12(1). doi: 10.1371/journal.pbio.1001767*
3. *Dess, G., Lumpkin, G.T., & Eisner. A. (2007). Strategic Management: Creating Competitive Advantage (3rd ed). The McGraw-Hill companies, Inc.*
4. *Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. American Psychologist, 49(8), 709- 724.*
5. *Epstein, S. (2008). Intuition from the perspective of cognitive-experiential self-theory, in H. Plessner, C. Betsch, & T. Betsch (eds.), Intuition in Judgment and Decision Making, 23-37, NY: Erlbaum, New York.*
6. *Epstein, S., Pacini, R., Denes-Raj, V., &Heier, H., (1996). Individual differences in intuitive-experiential and analytical-rational thinking styles, Journal of Personality and Social Psychology, 71(2), 390-405.*
7. *Evans, J.St.B.T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition, Annual Review of Psychology, 59(1), 255-278.*
8. *Frederick, S. (2005). Cognitive reflection and decision making, Journal of Economic Perspectives, 19(4), 25-42.*

9. Gainotti, G. (2015). Inborn and experience-dependent models of categorical brain organization. A position paper, Frontiers in Human Neuroscience, http://dx.doi.org/10.3389/fnhum.2015.00002
10. Kahneman, D. (2003). A psychological perspective on economics, The American Economic Review, 93(2), 162-168.
11. Kahneman, D. (2013). Thinking, Fast and Slow, NY: Farrar, Straus and Giroux.
12. Lin, S.Y., &Burdine, R.D. (2005). Brain Asymmetry: Switching from Left to Right, Current Biology, 15(9), R343-R345.
13. Macneilage, P.F., Rogers, R.J, &Vallortigara, G. (2009). Origins of the Left & Right Brain, Scientific American, 301(1), 60-67.
14. Miller, E.K., & Cohen, J.D. (2001). An integrative theory of prefrontal cortex function, Annual Review of Neuroscience, 24(1), 167-202. doi:10.1146/annurev.neuro.24.1.167.
15. Niles, D. (2010). Creatives can work left-brain, right-brain simultaneously, Advertising Age, 81(26), 14.
16. Rangarajan, V., &Parvizi, J. (2016). Functional asymmetry between the left and right human fusiform gyrus explored through electrical brain stimulation, Neuropsychologia, 83, 29-36.
17. Scull, A. (2010). Left brain, right brain: One brain, two brains, Brain, 133(10), 3153-3156.
18. Sommer + Sommer. (2013).http://braintest.sommer-sommer.com/en/
19. Stanovich, K.E. (1999). Who is rational? Studies of individual differences in reasoning. Mahwah, NJ: Erlbaum.
20. Stanovich, K.E., &West, R.F. (2000). Individual differences in reasoning: Implications for the rationality debate? Behavioral and Brain Sciences, 23(5), 645-665.
21. Sperry, R.W. (1968). Hemispheredeconnection and unity in conscious awareness, American Psychologist, 23(10), 723-733.